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Kaelin et al.

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(54) **METHOD OF PRODUCING DRIVE ELEMENT FOR A TIMEPIECE BARREL INCLUDING A BARREL ARBOR AND MAINSPRING**

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(73) Assignee: **ETA SA Manufacture Horlogère Suisse**, Grenchen (CH)

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(22) Filed: **Apr. 24, 2013**

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(30) **Foreign Application Priority Data**

Apr. 25, 2012 (EP) 12165537

(51) **Int. Cl.**
G04B 1/16 (2006.01)
G04B 1/18 (2006.01)

(52) **U.S. Cl.**
CPC .. ***G04B 1/16*** (2013.01); ***G04B 1/18*** (2013.01); *Y10T 29/49581* (2015.01)

(58) **Field of Classification Search**
CPC G04B 1/14; G04B 1/16; G04B 1/18; Y10T 29/49581; Y10T 29/49579
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A method for fabricating a barrel arbor for a timepiece includes wire drawing a bar to form a continuous profile, projecting or re-entrant relative to a support sector having a touching-up axis parallel to the bar axis, and whose section matches that of complementary hooking to be made on the arbor and, in a touching-up operation, machining the complete external contour of the arbor. A drive element includes a determined spiral-coiled mainspring including at an inner end hooking having a defined profile and an arbor produced by this method including the support sector for supporting the first coil, and a complementary hooking having a complementary profile to the profile for pivoting together with the mainspring.

15 Claims, 13 Drawing Sheets

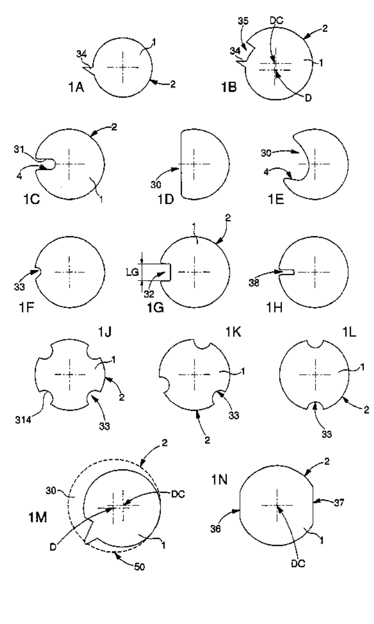
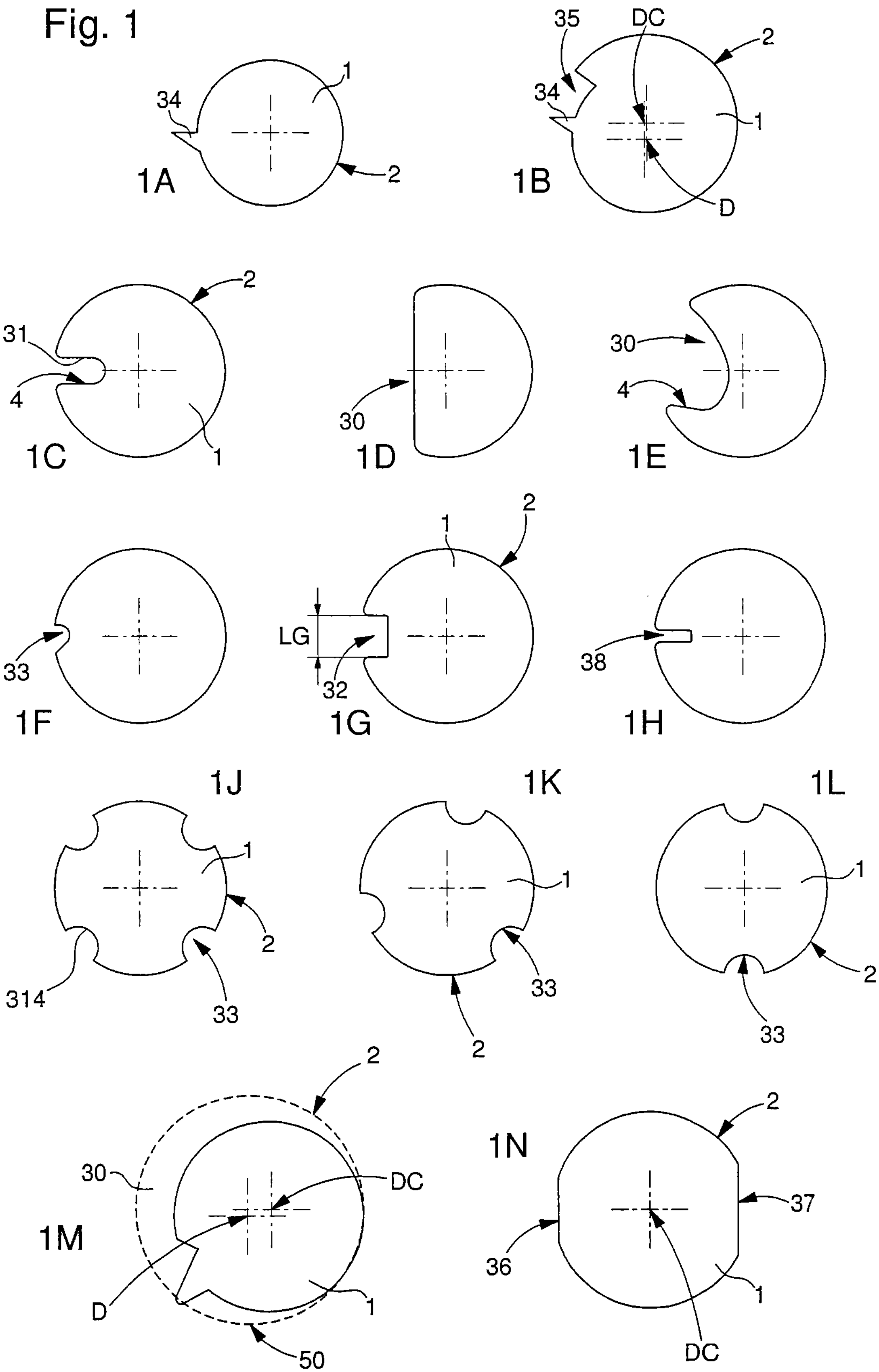


Fig. 1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1K
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Fig. 2A

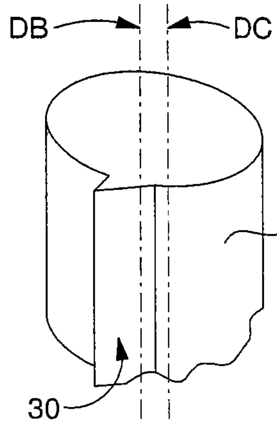


Fig. 2B

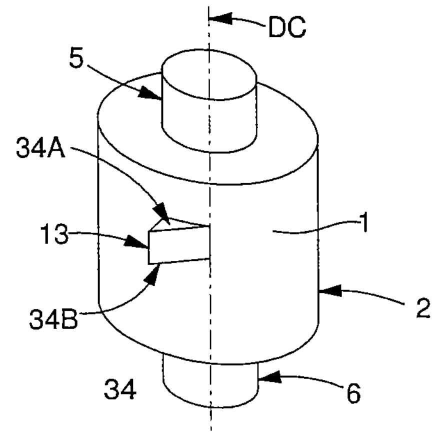


Fig. 3A

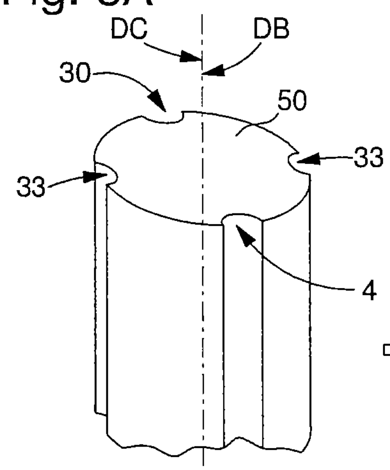


Fig. 3B

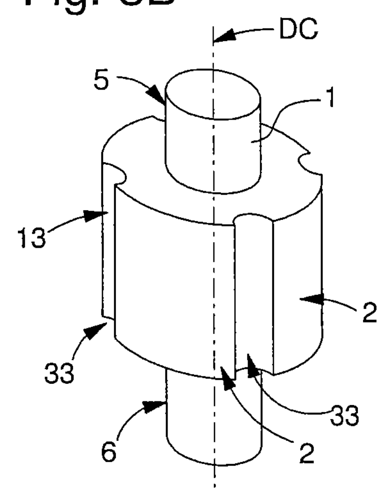


Fig. 4A

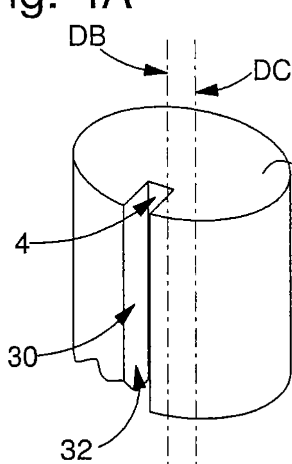


Fig. 4B

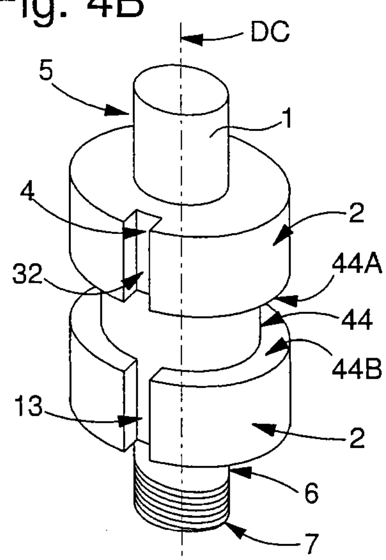


Fig. 6

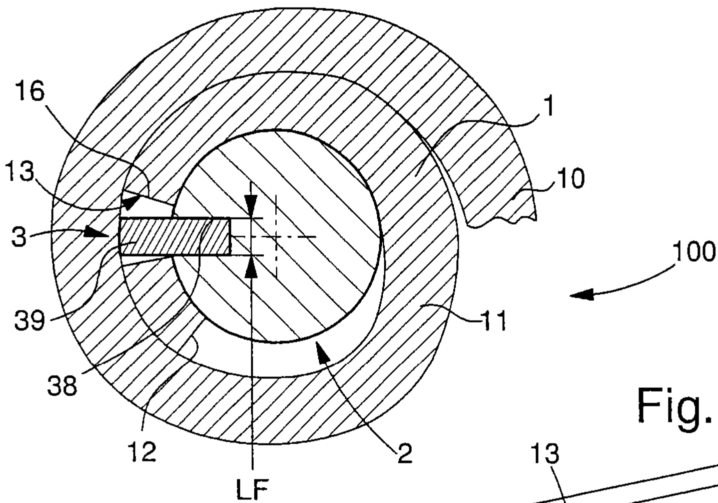


Fig. 7A

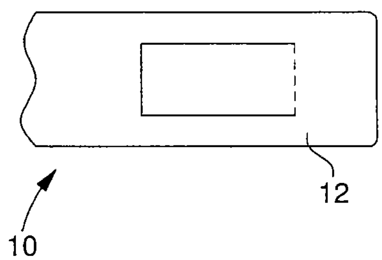


Fig. 7B

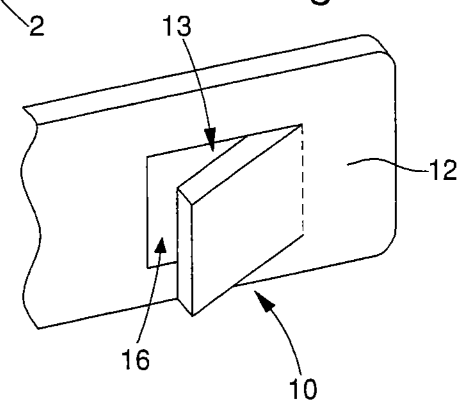


Fig. 5B

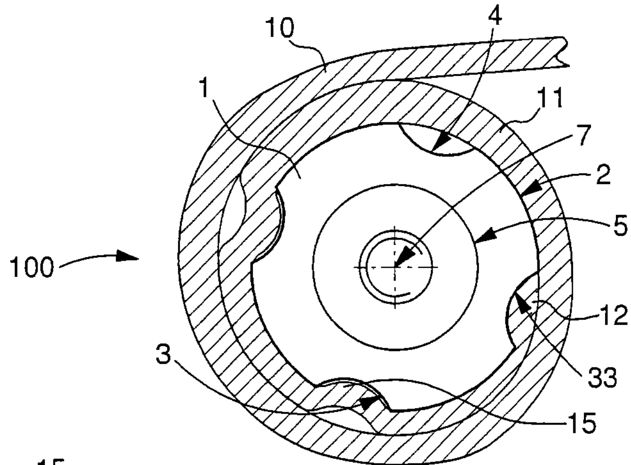
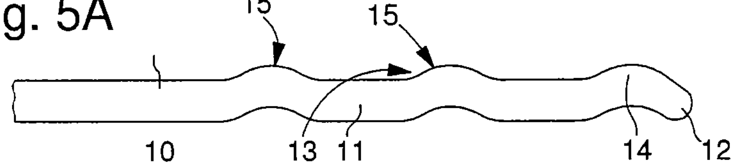


Fig. 5A



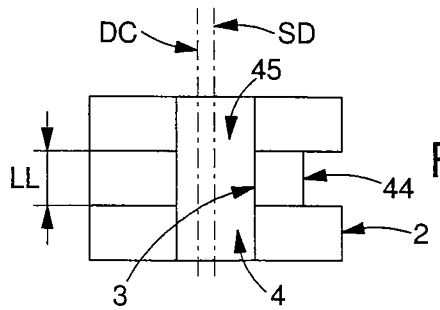


Fig. 9A

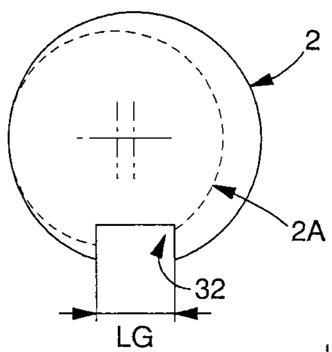


Fig. 9B

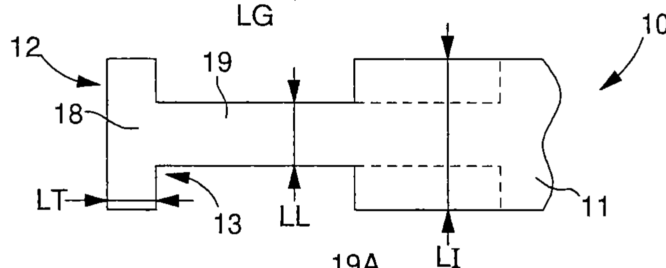


Fig. 9C

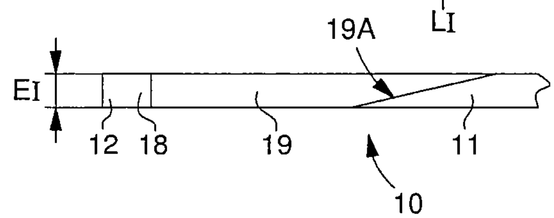


Fig. 9D

Fig. 16C

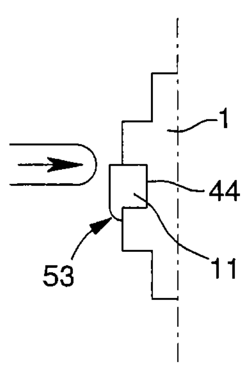


Fig. 16D

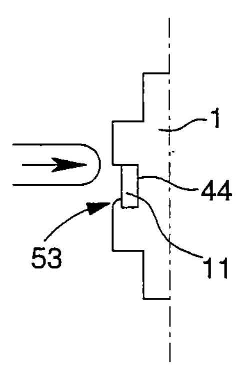


Fig. 5C

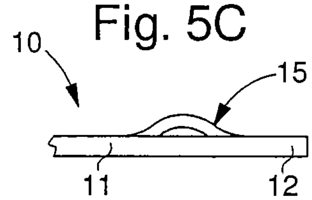


Fig. 5D

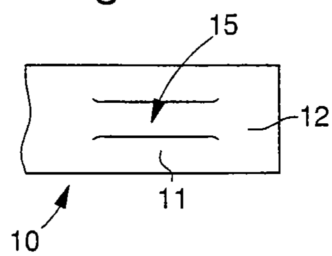


Fig. 8A

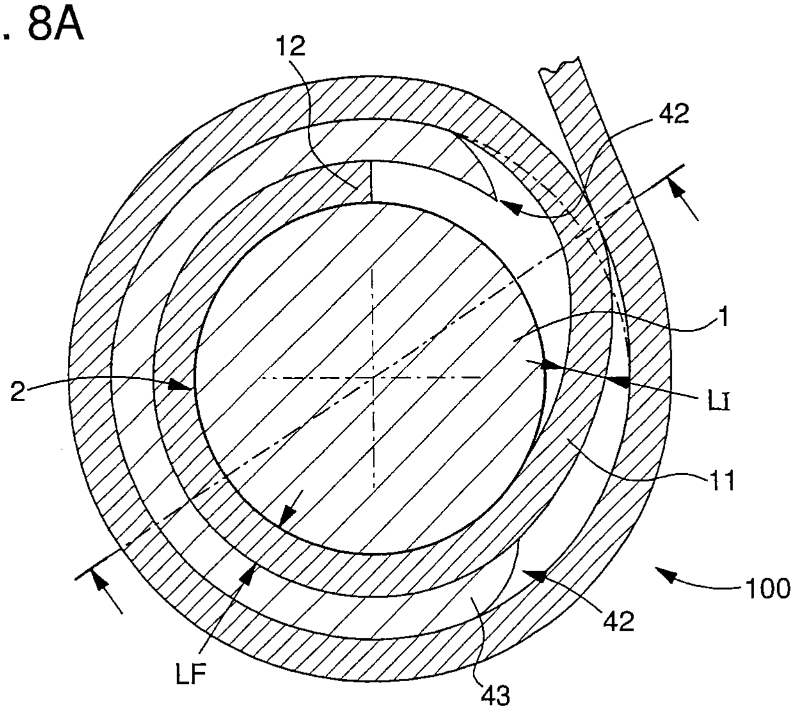
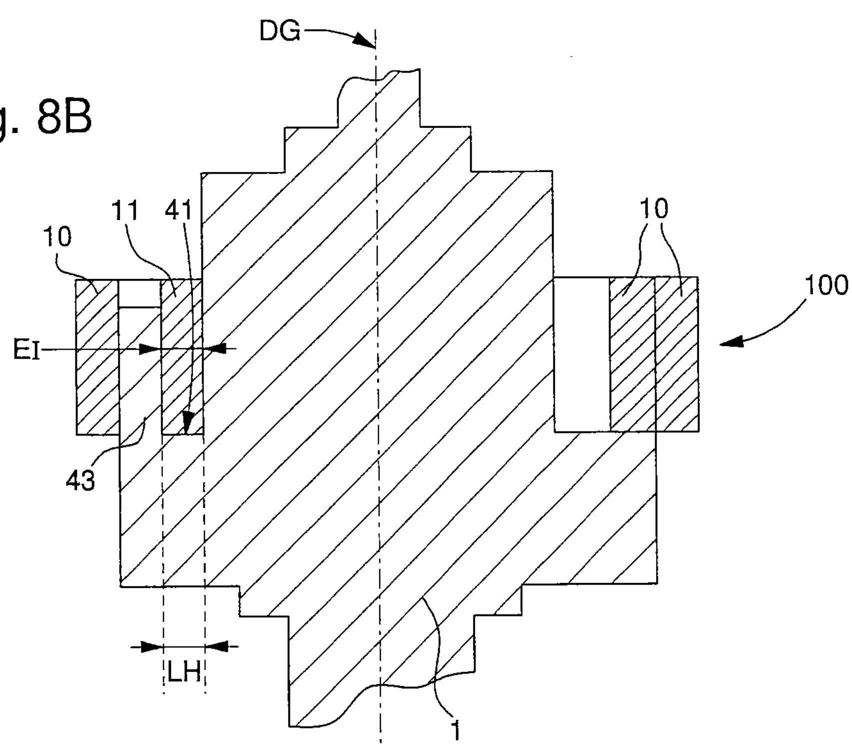


Fig. 8B



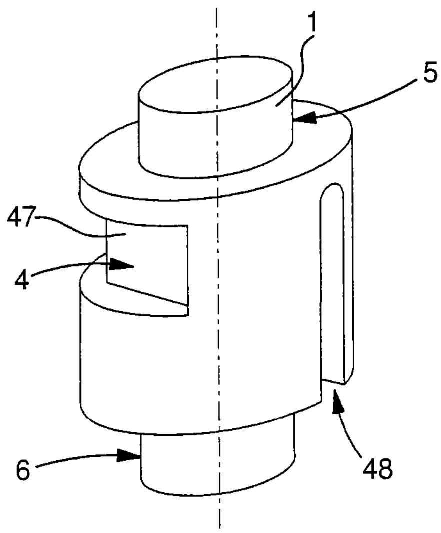


Fig. 11A

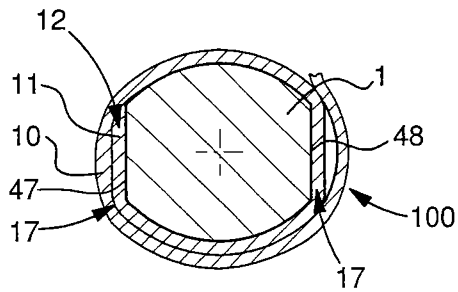


Fig. 11B

Fig. 10A

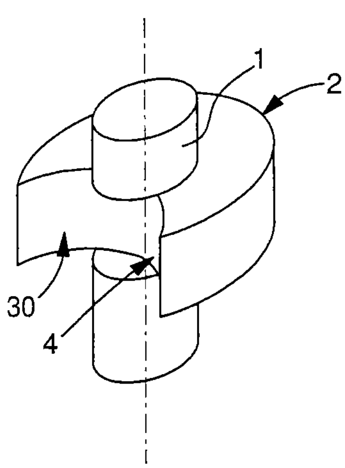


Fig. 10B

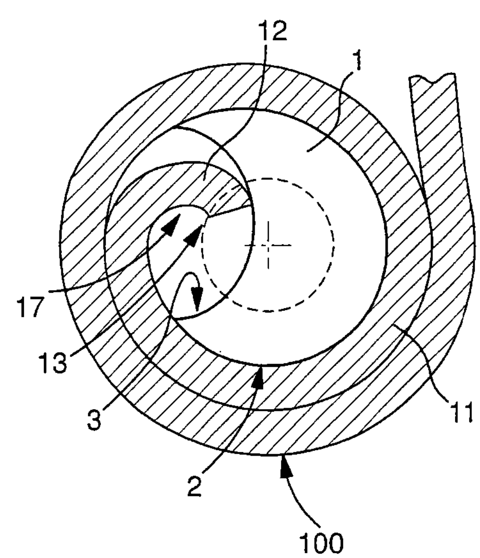
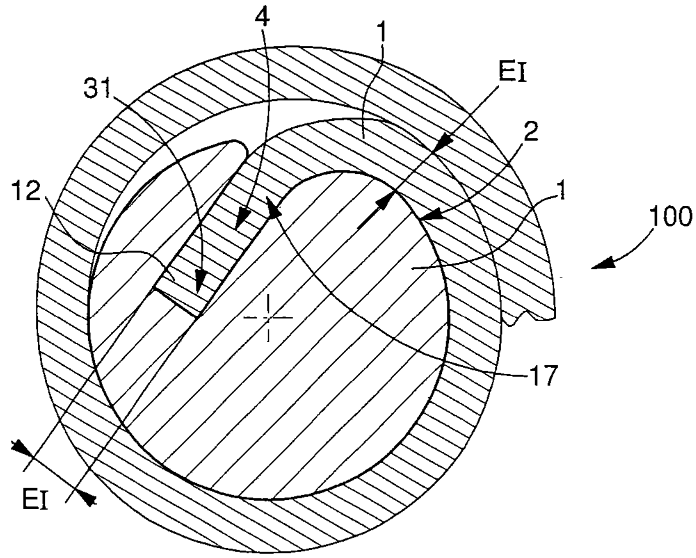


Fig. 12



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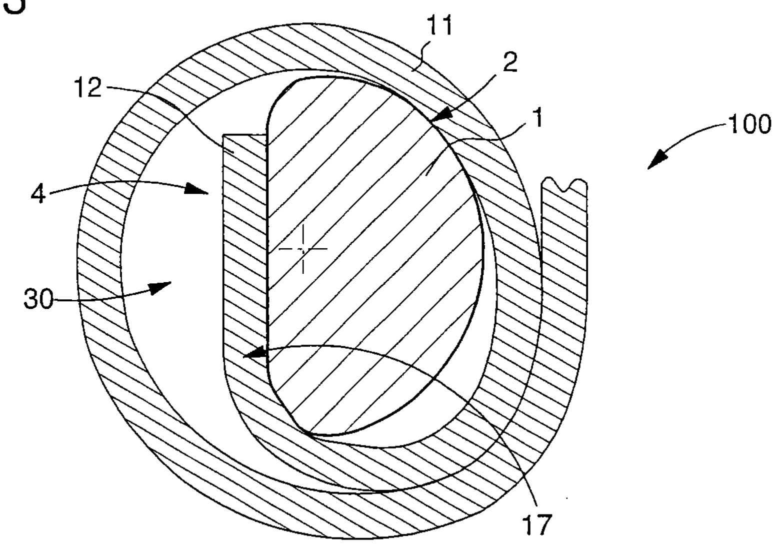
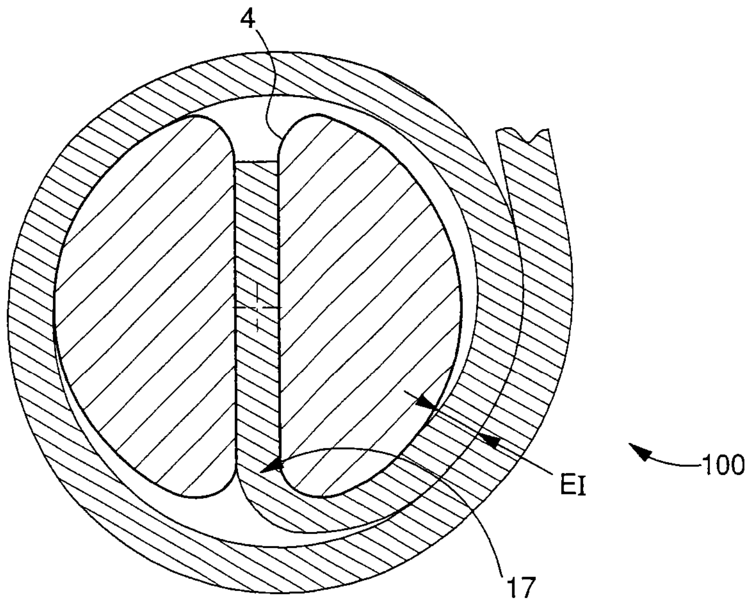


Fig. 14



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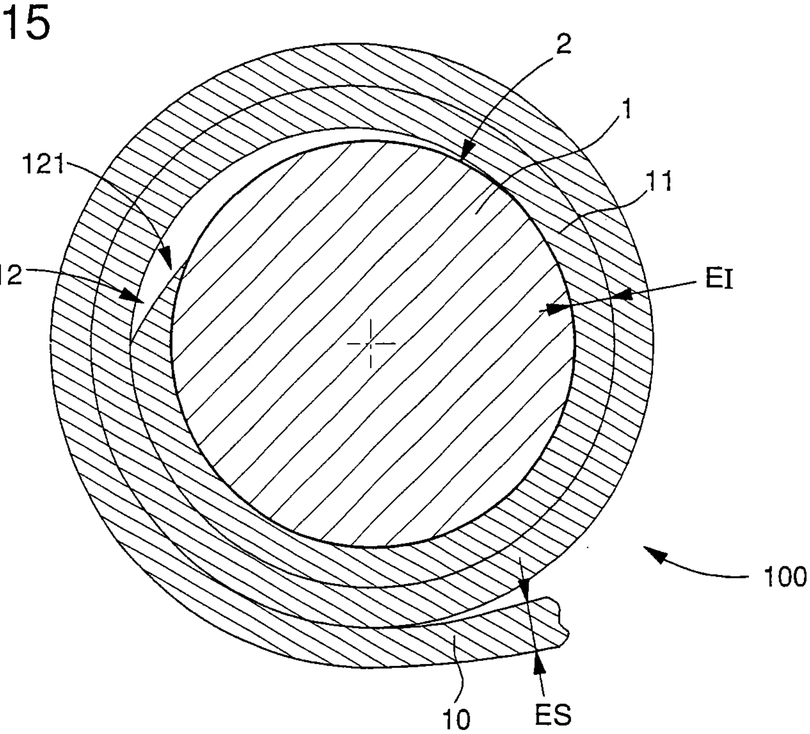
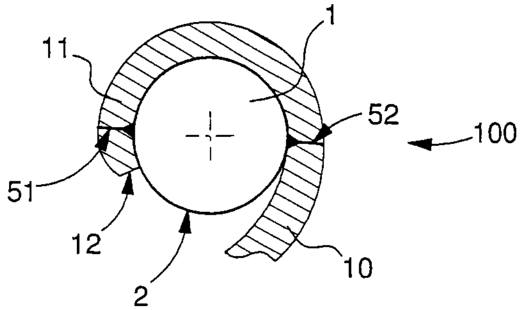


Fig. 16A



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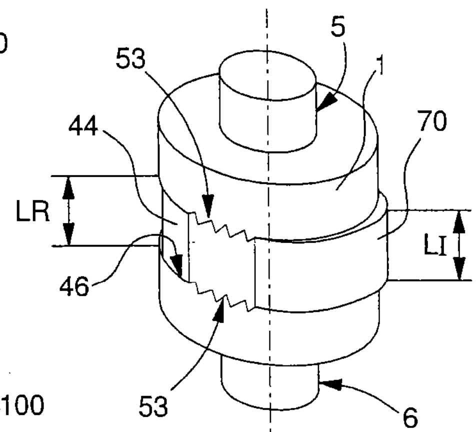


Fig. 17A

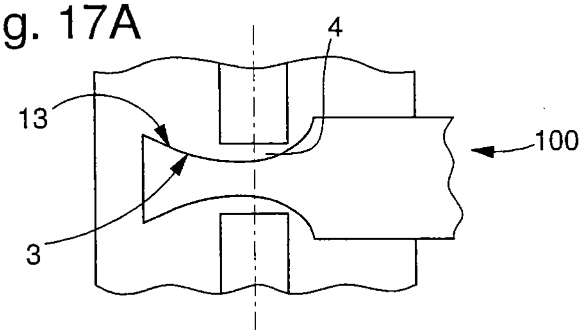
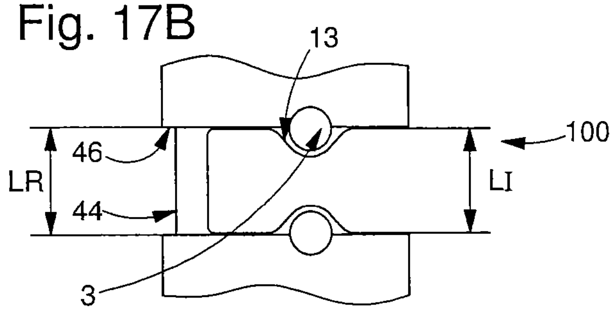


Fig. 17B



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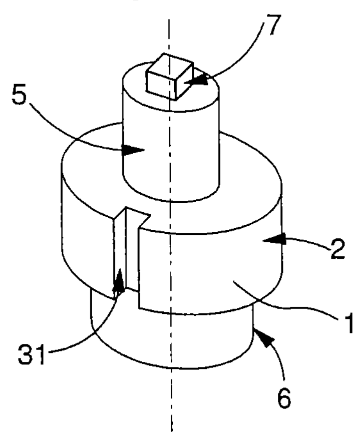

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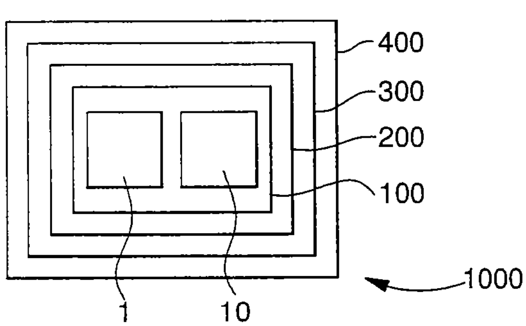


Fig. 20

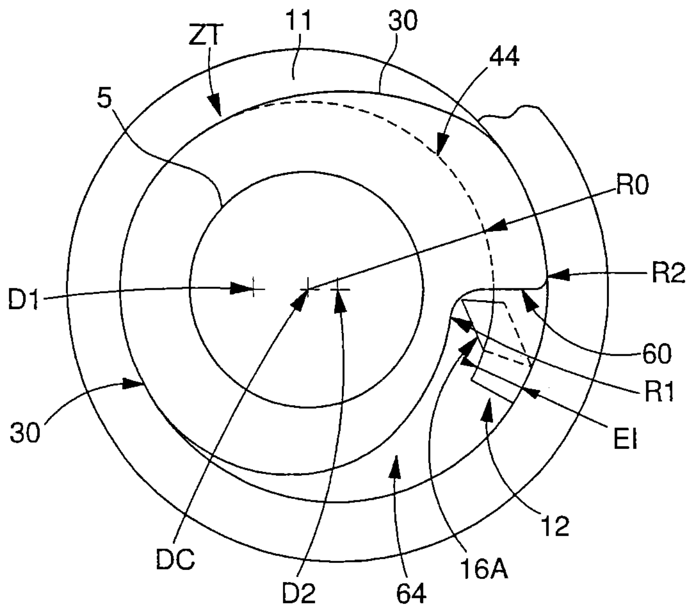
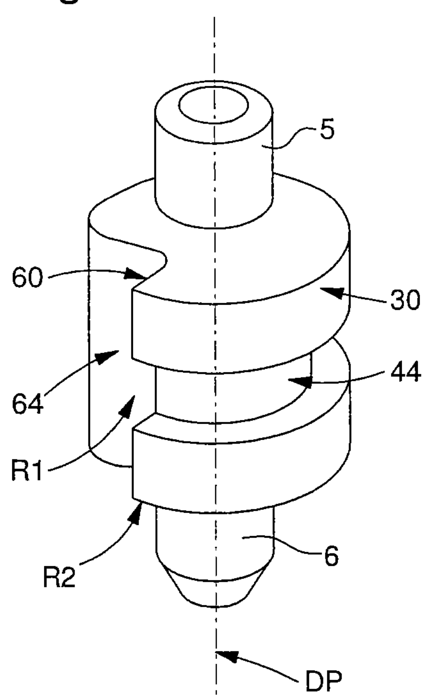


Fig. 21



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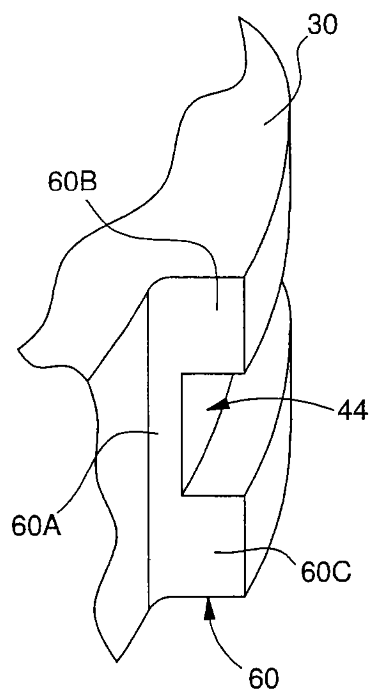


Fig. 23

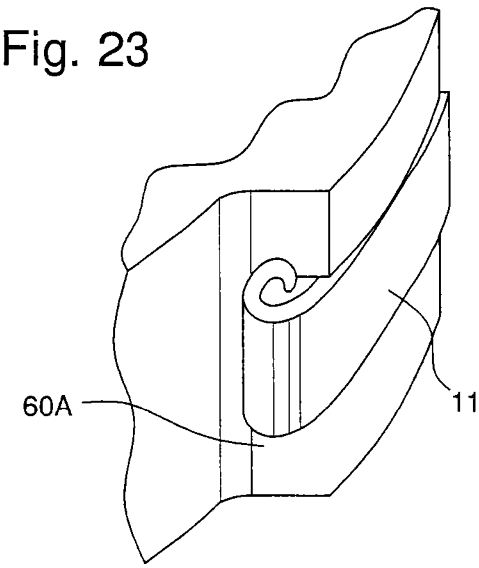


Fig. 24

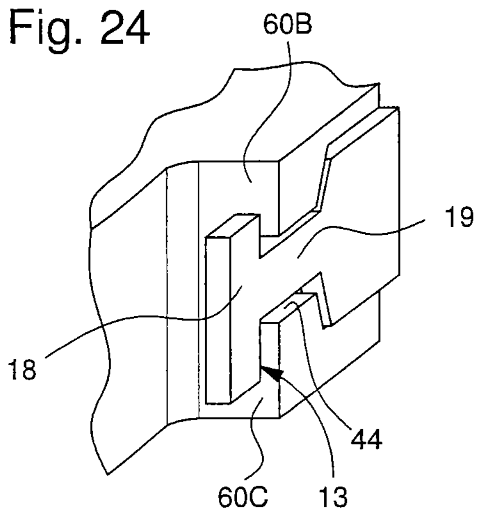


Fig. 25

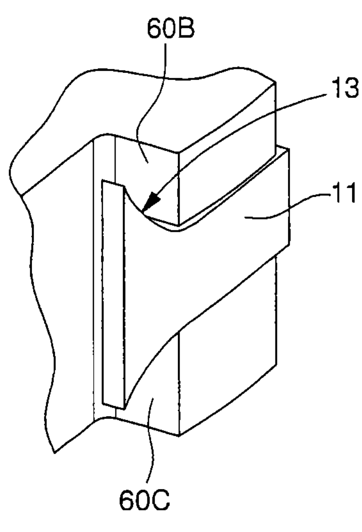


Fig. 26

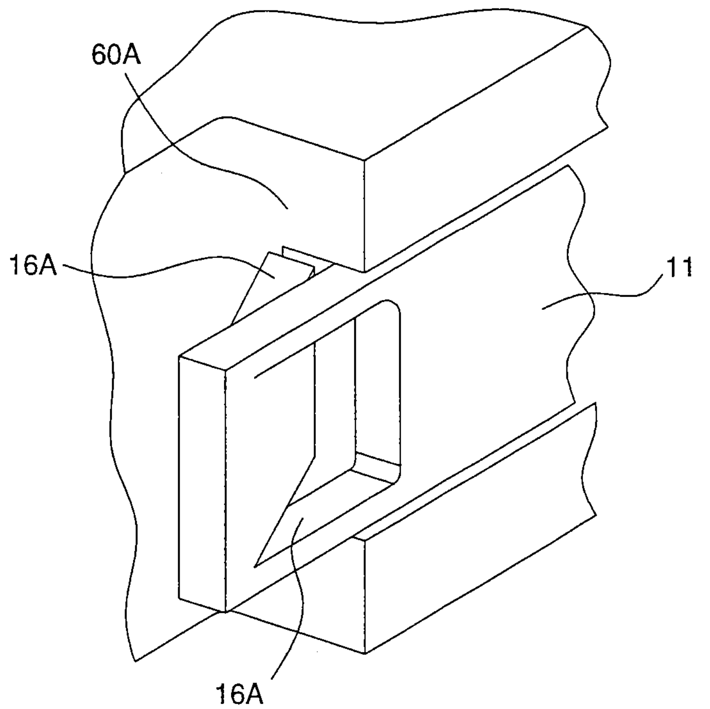
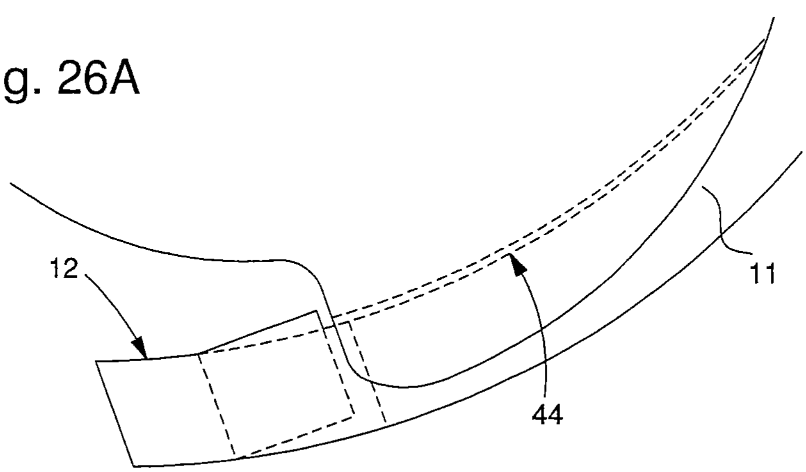
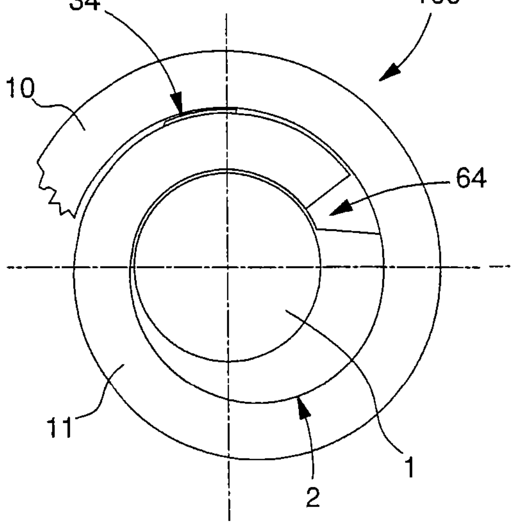


Fig. 26A





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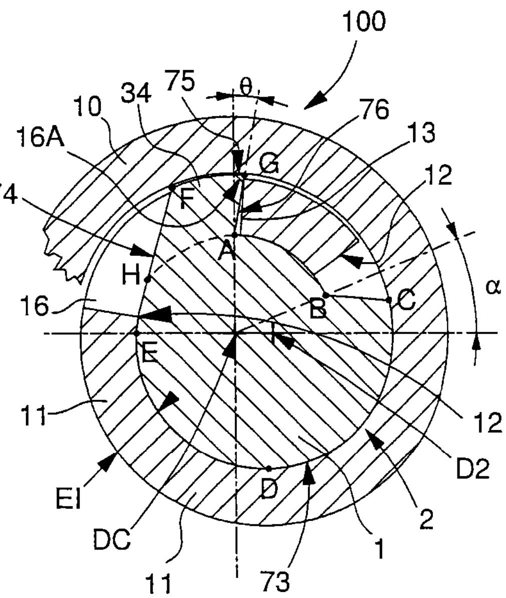


Fig. 28

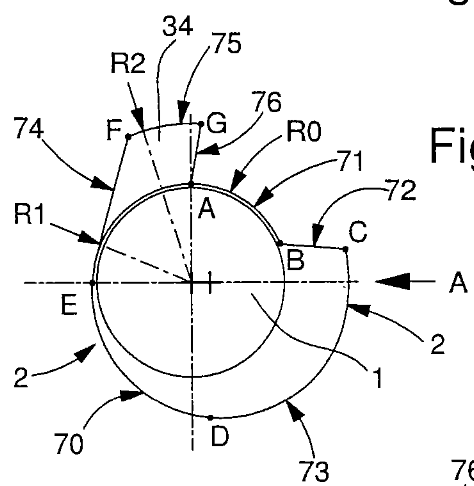


Fig. 29

Fig. 31

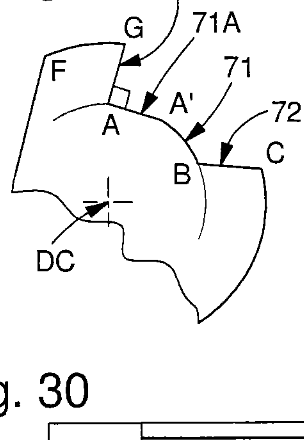


Fig. 32

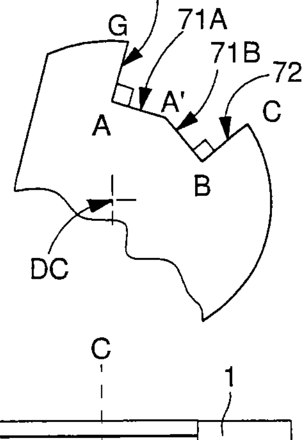
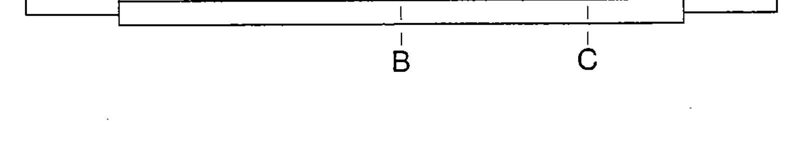


Fig. 30



METHOD OF PRODUCING DRIVE ELEMENT FOR A TIMEPIECE BARREL INCLUDING A BARREL ARBOR AND MAINSPRING

This application claims priority from European Patent Application No. 121655537.7 filed Apr. 25, 2012, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The invention concerns a method of manufacturing a timepiece barrel arbor.

The invention also concerns a drive element for a timepiece barrel, comprising at least, on the one hand, a spiral strip mainspring of determined type comprising a first inner coil of defined width and thickness, said first inner coil comprising, at an inner end, a holding or hooking means of defined profile for holding the first coil on a barrel arbor, and said drive element comprising, on the other hand, a barrel arbor of this type.

The invention also concerns a timepiece movement including at least one drive element of this type.

The invention concerns the field of horology, and more specifically the field of drive mechanisms.

BACKGROUND OF THE INVENTION

Any increase in capacity of timepiece drive mechanisms is limited by the volume available for the barrels comprising the energy storage springs. The available volume is delimited by the space available in the movement, and thus by the size of the drum incorporating the mainspring, and by the geometry of the barrel arbor which must be sized to transmit the maximum torque safely.

U.S. Pat. No. 3,846,974 A in the name of ETA discloses a barrel with drawn longitudinal grooves, for supporting the mainspring and hook. U.S. Pat. No. 820 252A in the name of PORTER WILSON discloses a similar arrangement.

U.S. Pat. No. 3,846,974A in the name of GIGER discloses a barrel with a very simple cylindrical arbor, having grooves drawn along generatrices, carrying the mainspring and ratchet. The ratchet has an inclined toothing to hold the arbor axially.

SUMMARY OF THE INVENTION

The invention proposes to improve the capacity of timepiece barrels, by employing barrel arbors with the smallest possible diameters, to increase the volume allowed for the mainspring, or to the mainsprings if there are several, and thus to increase the power reserve of such barrels.

It is not sufficient to apply a scale factor to existing barrel arbors, since the rigidity of the arbor must be guaranteed, or increased relative to usual arbor diameters, because of the greater torque that can be applied by the mainspring.

Therefore, methods should be chosen which guarantee good resistance of the arbors to bending and to fatigue while remaining at an acceptable cost. The morphology of the arbor determines the manner in which the mainspring is secured to the arbor, which must be reliable to prevent any unnecessary disassembly. All things being otherwise equal, particularly as regards the materials and thermal treatments used to make the arbors and mainsprings, it is the shape of the arbor, the shape of the mainspring, but also the type of assembly between the mainspring and the arbor, which determines the perfect behaviour of the drive element that they form together. A reduction, by a significant factor, in the arbor diameter relative to conventional manufacture, also requires a reduction in the radius of curvature of the first inner coil of the mainspring and the subsequent coils. The combined concept of the arbor, the associated mainspring and the way in which they are secured or driven, must take account of this constraint, to prevent any triangulation or faceting of the inner coils of the mainspring, which would reduce the life of said mainspring.

The invention therefore concerns a method of producing a drive element for a timepiece barrel, comprising, on the one hand, at least one spiral strip mainspring of determined type comprising a first inner coil with a defined first width and first thickness, said first inner coil comprising, for the holding thereof on a barrel arbor, at an inner end, a holding or hooking means having a determined profile, said drive element further comprising a barrel arbor, characterized in that, to make said arbor, in a first wire drawing operation, a bar is drawn so as to form, about an axis parallel to the drawing direction, a progressive profile in the shape of a snail between a smallest radius and a largest radius, with a step between the points of said largest radius and smallest radius, said profile in the shape of a snail comprising a support sector for said inner coil, and in that, in a second touching-up or turning operation of said drawn bar about a touching-up axis parallel to or merged with the drawing direction, the complete external contour of said arbor, comprising at least one cylindrical shoulder for the pivotal guiding of said arbor, is machined or turned, said step being used, either as a stop means for said means of holding or hooking said mainspring when said step is used as drawn, or as a complementary stop or hooking means for said mainspring holding or hooking means when said step is re-machined during said second touching-up or bar turning operation, and in that, in said second touching-up operation, a groove is machined, of revolution about a touching-up axis parallel to the drawing direction, and the width of which is adjusted along the direction of said touching-up axis, to hold in position said inner coil of said mainspring in the direction of said touching-up axis, on at least one point on the revolution thereof, said groove being secant with said step, between the surfaces thereof of smaller radius and of larger radius, and said groove being substantially tangent to said profile in the shape of a snail in a zone substantially diametrically opposite to said step relative to said touching-up axis of revolution of said groove.

According to a feature of the invention, at least one portion of said support sector is given a superficial roughness, greater than 12 Ra micrometers, in the form of a flute made during said wire drawing operation.

According to a feature of the invention, at least one portion of said support sector is given a superficial roughness, greater than 12 Ra micrometers, in the form of a milled portion made during said wire drawing operation.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will appear upon reading the following detailed description, with reference to the annexed drawings, in which:

FIGS. **1**A through **1**H and FIGS. **1**J through **1**N show a schematic cross-section, perpendicular to a bar direction, of various variants of wire drawn bar sections for making timepiece barrel arbors.

FIGS. **2**A and **2**B illustrate the making of a barrel arbor with a hook, by a first wire drawing operation according to FIG. **2**A and a touching-up operation according to FIG. **2**B.

FIGS. **3**A and **3**B illustrate the making of a barrel arbor comprising tangential grooves parallel to the barrel arbor, by a first wire drawing operation in FIG. **3**A and a touching-up operation in FIG. **3**B.

FIGS. **4**A and **4**B illustrate the making of a barrel arbor comprising a tangential groove parallel to the barrel arbor, intersecting a circular groove centred on a touching-up axis parallel to the direction of the arbor, by a first wire drawing operation in FIG. **4**A and a touching-up operation in FIG. **4**B.

FIG. **5**A illustrates the end section of a mainspring which has been passed through a special calender to create bosses in relief in distant waves, without incipient fractures, and FIG. **5**B shows a top view along the barrel axis of a drive element with a corresponding arbor, as shown in FIG. **1**J, which includes tangential peripheral grooves along generatrices, for receiving said bosses and holding the mainspring. FIGS. **5**C and **5**D illustrate, in a side view and a top view, the inner end of a mainspring stamped to create, between parallel slots along the elongation of said mainspring, at least one folded median lug forming a projecting boss relative to the rest of the mainspring surface.

FIG. **6** shows a cross-section perpendicular to the barrel axis of a drive element with an arbor comprising a narrow longitudinal slot in FIG. **1**H, or a pierced hole, in which a pin is inserted for holding the inner end of a mainspring, in an eyelet or a pierced hole or a hole comprised in the mainspring.

FIGS. **7**A and **7**B illustrate the stamping of the inner end of a mainspring, to define an aperture for hooking onto an arbor beak, or onto a pin in accordance with FIG. **6**.

FIG. **8***a* shows, in a similar manner to FIG. **2**, a variant wherein the arbor has a frontal groove opening through an aperture and receiving the inner end of the mainspring. FIG. **8**B is a cross-section of the same assembly in a plane passing through the arbor axis.

FIG. **9**A is an elevation view of an arbor showing a groove along a generatrix secant with a groove of revolution off-centre relative to the barrel axis. FIG. **9**B is an upper view of this arbor. FIG. **9**C is an elevation of the end of the associated mainspring, comprising a T-shaped end, and FIG. **9**D is the corresponding top view, showing a chamfer on the inner face.

FIG. **10**A shows a schematic, perspective view of an arbor comprising a recess with curved radius. FIG. **10**B shows a cross-section perpendicular to the barrel arbor of the same arbor provided with a mainspring whose inner end is wound onto a small radius, and housed in said recess.

FIG. **11**A shows a schematic perspective view of an arbor comprising, substantially parallel to each other, a flat portion and a slot housing the inner coil of the mainspring. FIG. **11**B shows a cross-section perpendicular to the barrel axis, said arbor being provided with a mainspring whose inner end abuts on the flat portion and is then slid into the slot.

FIG. **12** shows, in a similar manner to FIG. **2**, a variant wherein the arbor comprises a blind slot receiving the inner end of the mainspring.

FIG. **13** shows, in a similar manner to FIG. **2**, a variant wherein the arbor comprises a chamber delimited by a flat portion receiving the inner end of the mainspring.

FIG. **14** shows a schematic cross-section perpendicular to the barrel axis of a mainspring wherein the end of the inner coil is folded at an angle close to 90°, and inserted into an arbor comprising a transverse slot, in a diameter, for housing said mainspring with no play.

FIG. **15** shows a schematic cross-section perpendicular to the barrel arbor of a mainspring whose inner coils are thinned relative to the other coils, partially wound onto a cylindrical arbor.

FIG. **16**A illustrates an embodiment with a mainspring welded onto an arbor with two substantially diametrically opposite weld points, and FIG. **16**B illustrates a mainspring mounted and fitted into a groove of an arbor, then hammered into position in order to be retained. FIG. **16**C shows a schematic cross-section passing through the axis of a mainspring mounted to project into a circular groove, and subjected, on the top side, to the action of a thumb wheel to deform the edge thereof, the lower edge being shown with a deformation surface resulting from the action of said thumb wheel on the mainspring, whereas FIG. **16**D illustrates, in a similar manner, which is preferred in the usual case where the hardness of the mainspring is greater than that of the arbor, wherein the thumb wheel is applied to the walls of a groove in which the mainspring is clamped to trap said mainspring underneath the deformation zones.

FIG. **17**A illustrates a particular embodiment wherein the inner end of the mainspring is dovetailed, to cooperate with an opposing profile arranged on the arbor, comprising two shoulders here. FIG. **17**B illustrates a similar variant with a mainspring end comprising two recesses, cooperating as a stop member with two pins plugged into the corresponding arbor.

FIG. **18** illustrates, in perspective, an arbor with a drawn tangential groove, and a ratchet driving means in the shape of a square.

FIG. **19** is a block diagram of a timepiece, comprising a movement which includes a barrel, in turn including a drive element comprising an arbor and a mainspring according to the invention.

FIG. **20** shows a schematic, end view of a barrel drive element with a progressive profile in the shape of a snail, carrying a mainspring.

FIG. **21** shows a perspective view of the drive element of FIG. **20**.

FIG. **22** shows a perspective view of a detail of the arbor showing, seen from a recess receiving the inner end of the coil, an arbor support surface which is intended to cooperate with a mainspring stopping surface, said support surface being extended on both sides by a peripheral groove arranged for receiving the mainspring, over a tapered part of the thickness thereof throughout the winding of the mainspring.

FIGS. **23** to **26** illustrate, in a similar manner to FIG. **22**, this same zone of the arbor fitted with a mainspring, whose stop surface takes various forms: a winding or fold in FIG. **23**, a T-shaped cut-out in FIG. **24**, a dovetailed cut-out in FIG. **25**, a stamped eyelet forming a tongue in FIG. **26**, shown in an end view in FIG. **26**A.

FIGS. **27** to **30** illustrate an embodiment having a profile well suited to an arbor of very small diameter:

FIG. **27** shows a schematic, end view of a barrel drive element with a progressive profile in the shape of a snail, carrying a mainspring.

FIG. **28** is a transverse cross-section of the drive element of FIG. **27** in a plane passing through a hook comprised in the arbor.

FIG. **29** is an end view showing only the arbor of the assembly.

FIG. **30** is a side view of the same arbor in direction A of FIG. **29**.

FIGS. **31** and **32** partially illustrate two variants of the arbor profile in the area receiving the inner end of the mainspring.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The invention concerns a method of producing a drive element **100** for a timepiece barrel, comprising at least one spiral strip mainspring **10** of determined type comprising a first inner coil **11** having a defined first width LI and first thickness EI. This first inner coil **11** comprises, for the holding thereof on a barrel arbor **1**, at an inner end **12**, a holding or hooking means **13** having a defined profile **14**. This profile **14** may take various forms, particularly a stamped or machined eyelet, a fold made by folding an edge made by rolling, a boss, a notching, a projecting element, or a cut-out portion, or simply a cylindrical profile for the proper local support of mainspring **10** on arbor **1** at a determined point, of the same radius of curvature, so as to secure said mainspring and arbor to each other by laser welding, welding, brazing, bonding or similar. Drive element **10** further includes a barrel arbor **1**.

According to the invention, to produce this arbor **1**, in a first wire drawing operation, a bar is wire drawn to make, about an axis parallel to the direction of wire drawing, a profile **30** whose section perpendicular to the wire drawing direction is a snail shape changing between a smaller radius R**1** and a larger radius R**2** with a step **60** between a projecting point **61** of larger radius R**2** and a re-entrant point **62** of smaller radius R**1**. With a zone **63** of smaller radius R**1**, this step **60** delimits a recess **64** about a re-entrant point **62**. This recess **64** is used in various ways according to the method of securing mainspring **10**, as will be explained below. This snail-shaped profile **30** has, on at least one portion of the circumference thereof, a support sector **2** for the inner coil **11** of mainspring **10**.

In a second operation of touching-up or bar turning the wire drawn bar about a touching-up axis DC parallel to the direction of drawing, the complete external contour of arbor **1** is machined or turned. This complete contour includes at least one cylindrical shoulder **5**, **6** for pivotally guiding arbor **1**. When step **60** is used as drawn, step **60** is used as a stop means for holding or hooking means **13** for mainspring **10**. Or, when said step **60** is machined again during this second touching-up or bar turning operation, step **60** is used as complementary stop or hooking means **3** for holding or hooking means **13** for mainspring **10**.

In a first variant implementation of the invention, holding or hooking means **13** for mainspring **10** is limited to at least one support surface **65** of given curvature. The inner end **12** of mainspring **10** is positioned in recess **64**, abutting on step **60**, or in proximity thereto. The inner coil **11** extends away from step **60** and abuts on an ever increasing radius of arbor **1**. Mainspring **10** is thus wound onto arbor **1** on the side of recess **64** relative to step **60**. Mainspring **10** is irreversibly secured to arbor **1**, particularly by laser welding, welding, brazing, bonding or similar, between the inner support surface **65** of mainspring **10** and the zone **63** of smaller radius R**1**. This irreversible securing may be achieved in a point, or in a network of points, or along a generatrix or similar. In a particular embodiment, the securing method is repeated on another area of the arbor, for example substantially diametrically opposite relative to zone **63** of smaller radius R**1**. In this first variant, the difference between the smallest radius R**1** and the largest radius R**2** is substantially equal to the thickness EI of mainspring **10**, or at least to the thickness of mainspring **10** at the end of the first inner coil **11**. Thus the second coil is superposed on the first coil with no overhanging or step which would be detrimental to the fatigue resistance of mainspring **10**. This first variant concerns the case wherein step **60** is used as drawn, and acts then as a stop means for holding or hooking means **13** of mainspring **10**.

In a second variant implementation of the invention, mainspring **10** is applied to arbor **1** so that the inner end **12** of the first coil is positioned in recess **64**, mainspring **10** straddling the area around projecting point **62** so as to be wound onto arbor **1** on the side opposite recess **64** relative to step **60**. This second variant concerns the case where step **60** is re-machined in the second touching-up or bar turning operation, to form a complementary stop or hooking means **3** for holding or hooking means **13** of mainspring **10**. This touching-up is also necessary to enable mainspring **10** to pass over step **60** while guaranteeing the best possible support for mainspring **10** and limiting the shearing stresses to which it is subjected.

Preferably, in this second variant, in the second touching-up operation, a groove **44** is machined, of revolution about a touching-up axis DC parallel to the drawing direction, and having a width adjusted along the direction of said touching-up axis DC, for holding in position, in the direction of touching-up axis DC, the inner coil **11** of mainspring **10**, on at least one point of the revolution thereof. This groove **44** is secant with step **60** between the surfaces thereof of smaller radius R**1** and of larger radius R**2** and preferably, groove **44** is substantially tangential to snail-shaped profile **30** in a tangency zone ZT substantially diametrically opposite step **60** relative to the touching-up axis DC of revolution of groove **44**.

Thus, in the first drawing operation, a bar **50** is wire drawn to form at least one continuous profile **30**, which is projecting or re-entrant relative to a support sector **2** having a circular or snail-shaped profile about an axis parallel to or merged with that of bar **50**. The cross-section of this continuous profile **30** matches the projection, in a plane perpendicular to the drawing direction, of complementary hooking means **3** to be made on arbor **1**, having a complementary profile to holding or hooking means **13** for a determined type of mainspring **10**, which the corresponding arbor **1** is devised to hook. Manufacture by wire drawing gives the superficial surfaces better fatigue resistance, and provides better distribution of the stresses on projecting or re-entrant relief portions, in comparison to machining technologies using tools having a small radius, which create significant concentration of stress, especially in re-entrant angles, and which make the arbor fragile. Work hardening resulting from the wire drawing affects the entire peripheral surface and particularly the hooking zones, which thus maintain a high level of superficial hardness, and good resistance to wear.

A solid, constructed along generatrices parallel to the same curve, elevated on the basis of a flat closed profile will be called a "prism" here within the descriptive geometric sense. Preferably in the case of this description, the prism is a straight prism, whose generatrices are parallel to a touching-up axis DC and perpendicular to a particular profile, particularly a circular or snail shaped profile. In the case of the first variant, the profile, when selected to be snail-shaped, is then made according to the thickness of the first inner coil **11** of a mainspring **10** with which arbor **1** is intended to cooperate, and the increase in the snail over the periphery thereof is close to the thickness EI of said first coil **11**, and calculated such that, when first coil **11** of the mainspring is wound onto arbor **1**, it permanently bears, or at least as much as possible, on the support sector **2** formed by the lateral surface of the prism having a snail-shaped cross-section. Thus, when mainspring **10** covers the inner end **12** of the first inner coil **11**, it is not deformed by any discontinuity of support between said support surface **2** and end **12**.

In a second touching-up operation by re-machining or bar turning about a touching-up axis DC, the complete external contour of arbor **1** is machined or turned. Preferably, since this is most economical, the second touching-up operation is a bar turning or turning operation.

FIGS. **1**A to **1**H and **1**J to **1**N illustrate various non-limiting section profiles after wire drawing and which are well suited to making barrel arbors. Preferably, the continuous profile **30** is straight, i.e. delimited by generatrices parallel to the axis of bar **50**. A twisted embodiment is possible, but involves higher costs, and the present description is limited to describing straight continuous profiles **30**.

In a particular and preferred implementation of the invention, the production of an arbor **1** is linked to the anticipated use of this arbor **1** with a spiral strip mainspring **10** of determined type, or belonging to a family of springs having common features as regards the interface thereof with the barrel arbor. This interface especially concerns the first inner coil **11** which has a free inner end **12**. This first coil **11** has a defined width LI and a defined thickness EI. This does not mean that inner end **12** cannot be made with a different profile, and/or a different width, and/or a different thickness, as will be seen in the following description.

In an embodiment according to the second variant, depending upon the case, the inner free end **12** may or may not include an eyelet **16**, which is for example stamped, or resulting from the folding of a three quarter stamped lug, as seen in FIGS. **7**A and **7**B. The free end **12** may also include a cut-out of particular shape, as will be explained below, and as seen for example in FIGS. **9**C, **17**A, **17**B.

In the case of FIG. **1**C, a slot **31**, having a width identical to the defined thickness EI of said first inner coil **11**, is selected for the section of continuous profile **30**. This embodiment is well suited to springs **10** comprising an end fold, forming a stop zone **17**, as seen in particular in FIG. **12**.

In the case of FIG. **1**G, a groove **32** of width LG greater than defined width LI of first inner coil **11**, is selected for the section of continuous profile **30**. Where an arbor **1** made on this basis is combined with a mainspring **10** comprising a T-shaped end **12**, as seen in FIG. **9**C, the width LG is greater than or equal to and preferably equal to the length LT of a transverse bar of the T-shaped profile.

In the case of FIG. **1**H, a narrow slot **38** having a width LF much smaller than defined width LI of first inner coil **11** is selected for the section of continuous profile **30**. This narrow slot **38** is provided for the insertion of a pin **39** or a metal foil key, which form complementary hooking means **3** of arbor **1**, which cooperates with an eyelet **16** of end **12** of first coil **11** of mainspring **10**, as seen in FIG. **6**. This narrow slot embodiment is an advantageous alternative to drilling a pin hole, which becomes a complex operation on an arbor of very small diameter, around several tens of millimeters, close to 1 millimeter.

In the case of FIGS. **1**F, **1**J, **1**K, **1**L, the section of continuous profile **30** is selected to be a tangential groove **33**, along a generatrix of bar **50**, whose profile matches that of a boss **15** comprised in first inner coil **11** of a corresponding mainspring, or whose profile is simply of sufficient size to form stop surfaces of a local raised portion of mainspring **10**: a fold, winding, hook, lug, collar or similar.

Preferably, the profile of this groove **33** is an arc of a circle or similar, the centre of which is towards the exterior of the profile, and which is connected by two radii of concavity opposite its own to the circular or snail-shaped contour of the section of support sector **2**. The section of boss **15** of the corresponding mainspring **10** is also in an arc of a circle, or similar, connected by two radii of concavity opposite to its own to the strand of the mainspring.

In the particular case of FIGS. **1**J, **1**K, **1**L, the continuous profile **30** is that of a plurality of tangential grooves **33** each having a profile matching that of a boss **15**, grooves **33** being angularly equidistant about a cylinder, or about a prism of snail-shaped section parallel to the pivot axis of arbor **1**, comprising support sector **2** in the drawing direction. The embodiment of FIG. **1**J is shown again in FIGS. **3**A and **3**B, for manufacturing an arbor **1** forming a drive element **100** according to FIG. **15**B, the other component of which is the special mainspring **10** of FIG. **5**A, which shows the end section **12** of this type of mainspring **10** which has been passed into a special calender to create bosses **15** in relief in distant waves, without any incipient cracks. Grooves **33**, preferably having a rounded profile and with ends curved at a radius, form peripheral tangential grooves along generatrices, for receiving these bosses **15** and for retaining mainspring **10** perfectly, while ensuring good support contact between first coil **11** of mainspring **10** and the cylindrical sectors **2**.

FIG. **1**M illustrates the case of a relief portion with any type of hooking, having a continuous profile **30** which is both projecting and re-entrant, and the inscribing thereof, and a surface with cylindrical shoulders **2** within the envelope of bar **50**.

FIG. **1**N illustrates the case of a continuous profile **30** comprising two substantially diametrically opposite flat portions **36** and **37**, which are preferably diametrically opposite relative to the drawing direction of a support sector **2**. This embodiment is well suited to a variant illustrated in FIG. **16**A, wherein the first inner coil **11** of mainspring **10** is welded at two diametrically opposite points, and preferably on flat portions **36** or **37** of this type.

FIGS. **2** to **4** illustrate advantageous embodiments on the basis of a wire drawn profile, which guarantee proper holding of the mainspring.

FIG. **2** illustrates the embodiment of a barrel arbor **1** with a hook **34**, by a first wire drawing operation according to FIG. **2**A, with a continuous profile **30** according to FIG. **1**A, or **1**B in a variant wherein the continuous profile **30** is that of a hook **34** joined to a housing **35** which provides better covering of first inner coil **11** by the next coil. The profile of hook **34** joined to said housing **35** matches that of an eyelet **16** comprised in an inner end **12** of the first inner coil **11** of a spiral strip mainspring **10** of determined type. During the touching-up operation according to FIG. **2**B, particularly via bar turning, the top **34**A and bottom **34**B faces delimiting hook **34** are turned to cooperate with eyelet **16** and top and bottom shoulders **5** and **6** are rotated to pivotally guide arbor **1**. This conventional configuration of a barrel arbor with a hook is thus achieved in a robust and economical manner, as a result of the wire drawing and immediate finishing by bar turning.

FIG. **3** illustrates the embodiment of a barrel arbor **1** comprising tangential grooves **33** parallel to the barrel arbor, by a first wire drawing operation according to FIG. **3**A, with a continuous profile **30** as illustrated, for example, in FIGS. **1**F, **1**J, **1**K, **1**L and a touching-up operation according to FIG. **3**B, also preferably via bar turning for finishing arbor **1** and the top **5** and bottom **6** shoulders thereof. As explained above and seen in FIGS. **5**A and **5**B, this arbor **1**, in conjunction with a mainspring **10** arranged in a particular manner and with no incipient cracks as a result of an undulated profile having no folding zones or zones of very small radius, provides a very good peripheral hold of mainspring **10** over the entire area of the first coil **11**. FIGS. **5**C and **5**D illustrate an advantageous variant of mainspring **10**, which is stamped to create, between parallel slots along the elongation of the mainspring, at least one median folded lug forming a boss **15** projecting relative to the rest of the surface of mainspring **10**. This configuration has the advantage of correcting the shake of the mainspring. This configuration can be used, not only in the particular case where it is advantageous for at least one boss **15** to cooperate with grooves **33** of an arbor **1**, but also in the general case where it is desired to precisely position, in the direction of the barrel axis (or a balance axis or any axis intended to receive a timepiece mainspring), a spiral mainspring of this type, and in particular, in the case of a barrel, relative to the drum and to any cover.

FIG. **4** illustrates the embodiment of a barrel arbor **1** comprising a tangential groove **32** parallel to barrel arbor DB, intersecting a circular groove **44** centred on a touching-up axis parallel to the axis of the arbor and thus off-centre relative to the barrel axis, by a first wire drawing operation during which tangential groove **32** is made, according to FIG. **4**A, with a continuous profile **30** according to FIG. **1**G, and a touching-up operation according to FIG. **4**B, during which circular groove **43** and the top **44**A and bottom **44**B delimiting surfaces, and the top **5** and bottom **6** shoulders of arbor **1** are made.

Preferably, as explained above, tangential groove **32** has a width LG greater than the defined width LI of the first inner coil **11**. FIGS. **9**C and **9**D show a preferred variant of the associated mainspring **10**, comprising a T-shaped end **12**, with a head **18** of length LT connected to the rest of mainspring **10** by a core **19**, preferably adjacent to chamfers **19**A for improved winding support for the mainspring. Width LG is greater than or equal to and preferably equal to this length LT of a transverse bar. Preferably, the width LL of circular groove **44** is equal to the width of core **19**, and the bottom of groove **44** defines a cylindrical support surface **2**A for supporting said core **19**, the support sector **2** serving as support for the total width LI of the mainspring section, which follows core **19**, opposite head **18**.

This T-shaped profile is a non-limiting economical example. FIG. **17**A illustrates a particular embodiment of the dovetailed inner end of the mainspring, for cooperating with an opposing profile arranged on the arbor, here comprising two shoulders. FIG. **17**B illustrates a similar variant with a mainspring end **12** comprising two recesses, cooperating as a stop with two pins fitted into the corresponding arbor **1**. Preferably, end **12** of mainspring **10** is embedded in a circular groove **44**, abutting on a flank **46** of the groove on at least one side, and preferably on both sides.

The method of producing an arbor **1** advantageously comprises an operation of machining a ratchet driving means **7** by internal or external threading, or turning, or milling facets, as seen in FIG. **19**, where said drive means **7** is formed by a conventional square. Preferably, to avoid touching-up, this drive means **7** consists of an internal or external thread achievable by turning during the second touching-up operation of arbor **1** after wire drawing, as seen in FIG. **4**A (internal thread) or in FIG. **5**B (external thread).

FIGS. **8**A and **8**B show an arbor **1** comprising a frontal groove **41** opening through an aperture **42** and receiving the inner end **12** of mainspring **11**, made by a method which includes an operation of machining a frontal groove **41** of revolution about an axis DG parallel to or merged with pivot axis D, frontal groove **41** having a width LH equal to a defined width LI of the first inner coil **11** of a spiral strip mainspring **10** of determined type. This machining operation further includes the machining of at least one aperture **42** in an external wall **43** of frontal groove **41**, aperture **42** having a width larger than a defined thickness EI of the first inner coil **11** of a spiral strip mainspring **10** of determined type, to allow said first inner coil **11** to pass therein.

Preferably, during manufacture of an arbor **1** according to any of the methods described above, a superficial roughness of more than 12 Ra micrometers, is given to at least one portion of support sector **2** in the wire drawing direction, in the form of a flute made during the first wire drawing operation, or a knurling made during the second touching-up operation. This roughness allows a friction hold between the arbor and the mainspring, especially if the mainspring has a similar friction surface on first inner coil **11**, on the face thereof facing the axis of arbor **1**. Naturally, this type of friction surface may, as an alternative to this mechanical embodiment, result from a surface treatment, an electroplated type projection or similar.

The invention concerns a drive element **100** for a timepiece barrel, comprising at least a spiral strip mainspring **10** of determined type comprising a first inner coil **11** having a defined width LI and thickness EI and the first inner coil **11** comprising, for the holding thereof on a barrel arbor **1**, at an inner end **12**, a holding or hooking means **13** having a determined profile **14**. This drive element **10** further includes a barrel arbor **1** preferably formed by wire drawing a bar **50** and made via one of the methods described above.

This arbor **1** includes a means **5**, **6** of pivotal guiding about a pivot axis DP, and includes at least one support sector **2** for supporting a first inner coil **11** of at least one mainspring **10**, arbor **1** including a complementary hooking means **3** having a profile **314** complementary to profile **14** of the holding and hooking means **13** for the pivotal cooperation thereof with said at least one mainspring **10**.

According to whether the holding or hooking means **13** of mainspring **10** is in projecting or recessed relief, the complementary hooking means **13** of arbor **1** is in respectively recessed or raised relief.

In the embodiments of FIG. **8**A, **8**B, **12**, **13** or **14**, of drive element **100**, set back internally relative to a cylinder or relative to a prism of snail-shaped section and parallel to the pivot axis of arbor **1**, comprising support sector **2**, arbor **1** includes at least one cavity **4** for receiving holding or hooking means **13** and/or at least one portion of the first inner coil **11**.

In the particular case of FIGS. **8**A and **8**B, this cavity **4** includes a frontal groove **41**, the width LH of which is arranged to receive mainspring **10** with minimum play. In an advantageous embodiment, frontal groove **41** is of revolution about an axis DG parallel to or merged with pivot axis D, and the width LH thereof is equal to the defined width LI of the first inner coil **11** of a said mainspring **10**. arbor **1** includes at least one aperture **42** in an external wall **43** of frontal groove **41**, said aperture **42** having a width larger than the defined thickness EI of first inner coil **11**, to allow said first inner coil **11** to pass therein. Preferably, this aperture **12** is wide enough to allow first coil **11** to be held without excessive stress, yet small enough to ensure proper retention of end **12** of mainspring **10**. Preferably, the angle at the centre in which said aperture is inscribed is comprised between 120° and 180°.

In the particularly advantageous embodiment of drive element **100** according to FIG. **5**B, set back internally relative to a cylinder, or to a prism of snail-shaped section parallel to the pivot axis of arbor **1**, comprising support sector **2**, arbor **1** includes at least one cavity **4** for receiving holding or hooking means **13** and/or at least one portion of the first inner coil **11**, and the at least one cavity **4** includes a plurality of tangential grooves **33** parallel to pivot axis D and each having a profile matching that of a boss **15** comprised in the first inner coil **11** of a spiral strip mainspring **10** of determined type, the grooves **33** being preferably angularly equidistant about a cylinder, or about a prism of snail-shaped section parallel to the pivot axis of arbor **1**, comprising a support sector **2** in the wire drawing direction. This equidistance is not essential, but it has the advantage of enabling mainspring **10** to be presented in abutment, via the boss **15** thereof the closest to free end **12**, in any one of grooves **33**, the other bosses **15** then naturally being in phase with the other grooves **33**. Mainspring **10** then includes a series of bosses **15** having a lower or equal number to that of grooves **33**, separated by the same curvilinear pitch as grooves **33**, and arranged to fit into grooves **33**.

In a particular embodiment of drive element, set back internally relative to a cylinder or relative to a prism of snail-shaped section and parallel to the pivot axis of arbor **1**, comprising support sector **2**, arbor **1** includes at least one cavity **4** for receiving holding or hooking means **13** and/or at least one portion of the first inner coil **11**. The wire drawing direction of support sector **2** is parallel to or merged with pivot axis D, and at least one cavity **4** is sized to receive the inner end **12** or at least one portion of first inner coil **11** with no play, in the direction of width LI of mainspring **10**.

In the drive element of FIGS. **4**A, **9**A, **16**B, of drive element **100**, set back internally relative to a cylinder or relative to a prism of snail-shaped section and parallel to the pivot axis of arbor **1**, comprising support sector **2**, arbor **1** includes at least one cavity **4** for receiving holding or hooking means **13** and/or at least one portion of the first inner coil **11** and cavity **4** includes a groove **44** of revolution about the drawing direction of support sector **2** and having a width LR equal to the width LI of the first inner coil **11** of mainspring **10**.

In the embodiment of FIG. **6**, set back internally relative to a cylinder or relative to a prism of snail-shaped section and parallel to the pivot axis of arbor **1**, comprising support sector **2**, arbor **1** includes a narrow slot **38** having a width LF much smaller than the defined width LI of the first internal coil **11**, and into which a pin **39** or a metal foil key forming complementary hooking means **3** is inserted.

In the variants of FIGS. **10**B, **11**B, **12**, **13**, **14**, inner end **12** of first inner coil **11** of mainspring **10** is folded or rolled towards the wire drawing direction of support sector **2**, so as to form a drive stop **17**. FIGS. **10**A and **10**B illustrate an arbor **1** comprising a cavity **4** formed by a recess curved in a half moon. The corresponding mainspring **10** has an inner end **12** wound on a small radius and housed in said recess **4**. FIGS. **11***a* and **11**B illustrate an arbor **1** comprising, substantially parallel to each other, a flat portion **47** and a slot **48** for housing the inner coil **11** of mainspring **10**: the inner end **12** thereof abuts on flat portion **47** and coil **11** is slid into slot **48**.

In an advantageous embodiment illustrated in FIG. **15**, the defined thickness EI of first inner coil **11** of mainspring **10** is smaller than the thickness ES of the following coils of mainspring **10**. Said following coils either have a constant section relative to each other or a tapered section moving away from first inner coil **11**.

This embodiment is applicable to all the barrel arbor variants described here and enables the first inner coil **11** to be pressed onto arbor **1** in an optimum manner, and in particular onto the cylinder sector(s) comprised therein. Advantageously, the free end **12** includes a chamfer **121** or a curved portion, so as to allow the next coil to be wound properly.

In a particular embodiment, at least one inner end **12** of first inner coil **11** of mainspring **10** has, on the inner face thereof intended to abut on support sector **2** of arbor **1**, a roughness of more than 12 Ra micrometers.

The relative hold between mainspring **10** and arbor **1** may be achieved by removable complementary means, such as a hook and eye or similar. In an alternative, the hold may be achieved by a permanent connection between the mainspring and arbor, by an irreversible securing method, by welding, brazing, bonding or similar. In a particular version illustrated in FIG. **16**A of a drive element **100**, at least one mainspring **10** is welded onto arbor **1** at two substantially diametrically opposite points **51**, **52** relative to the direction of wire drawing of support sector **2**. In a variant wherein arbor **1** has a profile according to FIG. **1**N, these points **51** and **52** are applied to flat portions **36** and **37** of arbor **1**, substantially diametrically opposite to the wire drawing direction of support sector **2**.

The production methods proposed for arbors **1** specifically devised for springs **10** of determined type enable opposing elements to be sized to allow the assembly of one on the other with no play. In particular, at least one mainspring **10** is held with no play in an annular groove **44** of arbor **1** around support sector **2**, or in a straight groove **45** of arbor **1** along a generatrix of arbor **1**.

Advantageously, when irreversible retention is desired, inner end **12**, or at least one portion of first coil **11**, is retained irreversibly in groove **44**, **45** by welding or brazing, or, in a very economical manner, by hammering or local crushing in deformation zones **53**, on mainspring **10** and/or arbor **1**. FIGS. **16**B and **16**C illustrate a mainspring **10** fitted and mounted to project into a circular groove **44** of an arbor **1**, and hammered into position to be retained, particularly by the action of a knurl or similar, so as to create deformation surfaces **53** which immobilise the mainspring relative to the arbor. FIG. **16**D illustrates in a similar manner, which is preferred in the usual case where the hardness of the mainspring is greater than that of the arbor, an application where the knurl is applied to the walls of a groove in which the mainspring is clamped to confine the latter underneath deformation zones **53**.

FIGS. **20** to **26** illustrate particular embodiments of the second variant.

FIG. **20** shows a drive element **100** for a barrel with an arbor **1** having a tapered snail-shaped profile **30** carrying a mainspring **10**. FIGS. **21** and **22** show the configuration pertaining to this variant, with a support surface **3** formed by the zone of intersection between support face **60** and peripheral groove **14**, which defines, on both sides thereof and of a median zone **60**A, two particularly robust supports **60**B and **60**C working in compression, forming stop means for absorbing the stress caused by winding mainspring **10**.

Peripheral groove **44** is arranged to receive mainspring **10** over a decreasing portion of the thickness thereof throughout the winding of the mainspring: from total thickness EI of the mainspring which may be fitted onto support face **60**, or at least a significant fraction of said total thickness, for good axial retention of the mainspring, up to a tangency zone ZT where groove **44** is tangent with a peripheral support surface **2**, and where mainspring **10** is completely free axially.

In FIGS. **23** to **26**, the stop surface **13** of mainspring **10** takes various forms: a winding or fold in FIG. **23**, a T-shaped cut-out in FIG. **24**, a dovetailed cut-out in FIG. **25**, a stamped eyelet forming a tongue in FIG. **20** or FIG. **26**, the latter shown in an end view in FIG. **26**A.

FIGS. **27** to **30** illustrate a profile embodiment well suited to an arbor **1** of small dimensions. With the exception of a hook **34** which cooperates with an eyelet **16** of mainspring **10**, this arbor **1** has a snail-shaped profile **30**.

The radius R**0** which serves as a support for the end **12** of inner coil **11** of mainspring **10** has a very small diameter here, with a value of 0.26 mm, whereas the largest radius R2, which is equal to the maximum radial space requirement of hook **34**, and to the support of the second coil of the mainspring, has a value of 0.42 mm. The radial space devoted to the mainspring is therefore equal to a thickness of close to 0.08 mm. The K factor, which is the ratio between the core radius, here the radius R**0** of arbor **1**, and the thickness of mainspring **10**, is close to 1.6, which is a particularly low value since it is estimated, for usual horological mainspring (Nivaflex® or similar) and arbor (steel or stainless steel) quality, that this ratio must be higher than 10 to avoid breaking the arbor.

The minimum core radius R**0** depends especially on:

the Hertz pressure on the pivoting of arbor **1** with the bridge and the bottom plate, or with the cover and drum of the barrel, according to the type of assembly of arbor **1**. This depends on the mainspring torque, the pivot diameters and the height thereof and the materials in contact;

the twisting and bending stresses to which arbor **1** is subjected. This is also dependent on the mainspring torque and the geometry of the arbor;

the shearing stresses to which hook **34** of arbor **1** is subjected when mainspring **10** is wound about the core. This depends on the mainspring torque but also on the geometry of the hook, which in turn depends on the maximum aperture of eyelet **16**, which may be made in mainspring **1**, through which the hook drives mainspring **1** on the core;

on the space available between the core of arbor **1** and the second coil of mainspring **10** wound on the core in order to ensure that the inner end **12** of mainspring **10** at the centre does not disrupt the winding thereof. This depends above all on the thickness of mainspring **10**.

As seen in a particular variant illustrated in FIGS. **28** and **29**, the peripheral profile **70** of arbor **1** is broken down as follows:

in the area of hook **34** (section BB of FIG. **30**):

a first cylindrical sector **71**, having a minimum radius R**0**, centred on axis DC, between marks A and B,

a rapidly increasing junction zone **72** between marks B and C, which is flat and forms an angle α with a radial plane, said angle α being comprised between 0° and 45°,

a second cylindrical sector **73**, between marks C, D and E, centred on an axis D**2** which is off-centre relative to axis DC, said eccentricity being comprised between R**0**/**4** and R**0**/**3**;

a junction zone **74**, tangent to second sector **73**, between marks E and F, said junction zone is advantageously substantially flat; said junction zone **74** defines, in the portion thereof with the largest radial extension, the back of hook **34**;

a third cylindrical sector **75**, between marks F and G, centred on axis DC, forming the edge of hook **34** and the support zone for the second coil of mainspring **10** when it is superposed on the first coil **11**;

a support face **76**, between marks G and A, forming the active surface of hook **34** for cooperating in abutment with a stop surface **16**A of mainspring **10**, formed here by one of the faces of an eyelet **16**; preferably, this support face **76** is flat, and undercut relative to a radial plane originating from axis DC, so as to ensure support for mainspring **10**, regardless of the thickness of said mainspring **10**, on support face **76**;

in the zone outside hook **34** (section CC of FIG. **30**);

a first cylindrical sector **71**, between marks H and B, having a minimum radius R**0**, centred on axis DC; mark H is such that the curvilinear abscissa HA is smaller than the length of the aperture of eyelet **16** of mainspring **10**;

a rapidly increasing junction zone **72** between marks B and C, which is flat and forms an angle α with a radial plane, said angle α being comprised between 0° and 45°,

a second cylindrical sector **73**, between marks C, D, E and H, centred on an axis D**2** which is off-centre relative to axis DC, said eccentricity being comprised between R**0**/**4** and R**0**/**3**, and said second sector **73** being substantially tangent with the first sector **71** at H.

The variant of FIG. **30** shows a first zone which is broken down, on the one hand, into a flat portion **71**A, between marks A and A', and forming a right or obtuse angle at A with the flat support face **76**, so as to allow combined milling of surfaces **76** and **71**A, and on the other hand, the first cylindrical sector **71** extending between marks A' and B, having a minimum radius R**0**, centred on axis DC and whose tangent at B forms a right or obtuse angle with junction zone **72**.

The variant of FIG. **31** shows a first zone which is broken down, on the one hand, into a flat portion **71**A, between marks A and A', and perpendicular at A to the flat support face **76**, so as to allow combined milling of surfaces **76** and **71**A, and on the other hand, a second flat portion **71**B extending between marks A' and B, and forming a right or obtuse angle at B with the flat junction zone **72**, so as to allow combined milling of surfaces **71**B and **72**.

In the case of FIGS. **31** and **32**, the distance to axis DC from surfaces **71**A and **71**B is preferably comprised between the values 0.8 R**0** and R**0**.

All of the configurations set out above are suitable for stopping mainspring **10** on arbor **1** by a weld spot, laser weld (radial or parallel to the axis), brazing, bonding or similar.

The invention also concerns a timepiece movement **1000** including at least one drive element **100** of this type. This mechanism **1000** is a barrel **200**, or a movement **300** incorporating at least one barrel **200**, or a timepiece **400** incorporating at least one movement **300**, incorporating at least one barrel **200**.

What is claimed is:

1. A method of producing a drive element for a timepiece barrel, comprising at least one spiral strip mainspring of determined type comprising a first inner coil with a defined first width and first thickness, said first inner coil comprising, for the holding thereof on a barrel arbor, at an inner end, a holding or hooking means having a defined profile, said drive element further comprising a barrel arbor, the method comprising:

drawing, in a first wire drawing operation, a bar so as to form, about an axis parallel to a direction of the drawing, a progressive profile in a shape of a snail between a smaller radius and a larger radius, with a step between points on said larger radius and said smaller radius, said profile in the shape of a snail comprising a support sector for said inner coil; and

machining or turning, in a second touching-up or bar turning operation of said drawn bar about a touching-up axis parallel to or merged with the direction of the drawing, a complete external contour of said arbor, the complete external contour comprising at least one cylindrical shoulder for pivotally guiding said arbor,

wherein said step is used, either as a stop means for said means of holding or hooking said mainspring when said step is used as drawn, or as a complementary stop or hooking means for said holding or hooking means for said mainspring when said step is re-machined during said second touching-up or bar turning operation, and

wherein, in said second touching-up operation, a peripheral groove is machined, of a revolution about the touching-up axis parallel to the direction of the drawing, and a width of the groove is adjusted along the direction of said touching-up axis, to hold in position said inner coil of said mainspring in the direction of said touching-up axis, on at least one point on the revolution thereof, said groove being secant with said step, between the surfaces thereof of smallest radius and of largest radius, and said groove being substantially tangent to said profile in the shape of a snail in a zone substantially diametrically opposite to said step relative to said touching-up axis of revolution of said groove.

2. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said step is made with a difference between said smallest radius and said largest radius, which is greater than or equal to said first thickness of said first inner coil of said mainspring.

3. The method of manufacturing a drive element for a timepiece barrel according to claim **2**, wherein said means of holding or hooking said mainspring is made with a T-shaped profile at the inner end of said first inner coil, comprising a transverse bar attached by a core of reduced width to the first inner coil having said first width of said mainspring, and wherein the width of said groove is selected to be a width greater than or equal to that of said reduced width of said core.

4. The method of manufacturing a drive element for a timepiece barrel according to claim **2**, wherein said means of holding or hooking said mainspring is made with a dovetailed profile wherein a width of a widest portion is greater than the width of said groove, and wherein a narrowest portion is arranged to be immobilized in abutment on said step at an entry to said groove.

5. The method of manufacturing a drive element for a timepiece barrel according to claim **2**, wherein, after said groove has been machined, said holding or hooking means of said mainspring is placed in abutment on said step or on said complementary stop or hooking means machined from said step, wherein said mainspring is immobilized in an irreversible manner in said groove by welding, and/or brazing, and/or hammering said arbor and/or said mainspring.

6. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said holding or hooking means for said mainspring is made with at least one boss on said first inner coil, achieved by permanent local deformation of said mainspring.

7. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said holding or hooking means for said mainspring is made with at least one lug on said first inner coil made by stamping said mainspring.

8. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said holding or hooking means for said mainspring is made in a form of a driving stop mechanism by a fold and/or by rolling said mainspring towards said touching-up axis at the inner end thereof.

9. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said mainspring is made with an eyelet at the inner end of said first inner coil, and wherein said step is re-machined in the shape of a hook conjugated with a housing and having a profile matching that of said eyelet.

10. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said snail-shaped profile has two substantially diametrically opposite flat portions relative to said touching-up axis, and wherein said mainspring is welded and/or brazed onto said arbor in an irreversible manner on at least two points of said flat portions.

11. The method of manufacturing a drive element for a timepiece barrel to claim **1**, wherein said snail-shaped profile includes at least two flat portions for driving said arbor via a ratchet.

12. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein at least one portion of said support sector of said mainspring is given a superficial roughness, greater than 12 Ra micrometers, in a form of a flute made during said wire drawing operation.

13. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein at least one portion of said support sector of said mainspring is given a superficial roughness, greater than 12 Ra micrometers, in a form of a milled portion made during said wire drawing operation.

14. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein said mainspring is pre-laminated in a differential manner, and wherein said first thickness of said first inner coil of said mainspring is smaller than thicknesses of following coils of said mainspring, which have a constant or progressive section moving away from said first inner coil.

15. The method of manufacturing a drive element for a timepiece barrel according to claim **1**, wherein at least said inner end of said first inner coil of said mainspring is given a roughness of more than 12 Ra micrometers on an inner face thereof which will abut on a support sector of said arbor.

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